

A Strategic Approach to Making Hydropower Investment Decisions Based on  
Equipment Condition and Risk Management Principles

Bureau of Reclamation, Hydro-Québec, Corps of Engineers and Bonneville Power Administration

Successful strategic planning for capital investments in existing hydropower facilities requires consideration and balancing of many factors, including the risks and consequences of equipment failure. The goal of hydroAMP (the Hydropower Asset Management Partnership) is to create a framework to streamline and improve the evaluation of equipment condition to enhance asset management and investment decision-making. Condition assessments support:

- Prioritization of capital investments
  - Development of long-term investment strategies
- Coordination of O&M budgeting processes and practices
  - Identification and tracking of performance goals

Technical teams comprised of experts from the hydroAMP organizations have developed condition assessment guides for circuit breakers, emergency closure gates and valves, generators (and large pump motors), governors, GSU transformers, surge arresters, and turbine runners. Assessment guides for compressed air systems, cranes, exciters, and station batteries are also currently being developed. A two-tiered approach for assessing equipment condition is used. Tier 1 relies on test data, inspection results, and other information that is readily available or easily obtained during routine operation and maintenance activities. A low condition index may indicate the need for a Tier 2 evaluation, comprised of specialized tests and a higher level of expertise, to refine the condition rating.

Equipment condition indices assist management and other personnel involved in making decisions on replacement or rehabilitation when faced with competing demands and limited resources. The simplest approach involves using condition indices to prioritize, rank and sort equipment needs. This analysis may be done horizontally across an organization to determine the replacement order for similar types of equipment (e.g., to develop a transformer or circuit breaker replacement program). Condition indices can also be combined vertically into an integrated generating unit (i.e., turbine, generator, circuit breaker, and transformer) index or into an overall facility index (including batteries and plant other equipment). Condition indices may be used to formulate a business case that addresses a wide range of factors such as risk of failure, efficiency, safety, economic, environmental, political and regulatory consequences, as well as other considerations. The analysis tools being designed by hydroAMP will be open and flexible to fit into existing maintenance, planning, budgeting, and decision-making structures.

A pilot project is currently being coordinated at select powerplants in the Corps’ Pacific, Central, and Atlantic regions to perform Tier 1 assessments of their turbines, generators, circuit breakers, and transformers. In addition, powerplants in the Federal Columbia River Power System (FCRPS) in the Pacific Northwest will perform Tier 1 condition assessments during FY04. Experience from these applications will be used to improve the condition assessment procedures and outputs.

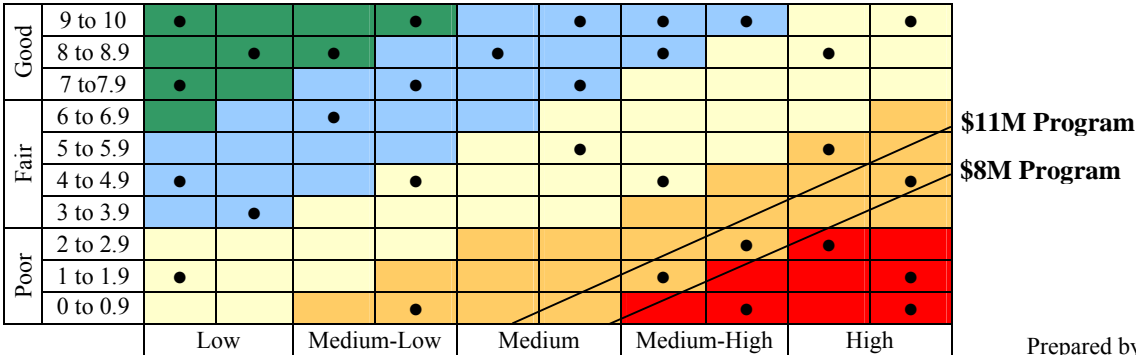
Several condition assessment tools are now available for testing and field validation. Use of these “draft” guides is encouraged, and feedback on ways to improve the guides is essential for further development of the condition assessment and asset management tools being created by the hydroAMP teams.

Example: Tier 1 Analysis of a GSU Transformer

Transformer Condition Summary					Condition-Based Alternatives	
No.	Condition Indicator	Score	Weighting Factor	Total Score	Condition Index	Suggested Course of Action
1	Oil Analysis	3	1.143	3.429	≥ 7.0 and ≤ 10 (Good)	Continue O&M without restriction. Repeat condition assessment as needed.
2	Power Factor and Excitation Current Tests	2	0.952	1.904	≥ 3.0 and < 7.0 (Fair)	Continue operation but reevaluate O&M practices. Consider using appropriate Tier 2 tests. Conduct full risk-economic assessment. Repeat condition assessment process as needed.
3	Operation and Maintenance History	2	0.762	1.524		
4	Age	2	0.476	0.952	≥ 0 and < 3.0 (Poor)	Immediate evaluation including additional Tier 2 testing. Consultation with experts. Adjust O&M as prudent. Begin replacement/rehabilitation process.
	Condition Index (Sum of individual Total Scores)			7.8		

- 1 Perform Tier 1 assessment to score condition indicators and calculate the Condition Index.
- 2 Use the Condition Index to rate condition and determine a course of action.

Risk Map



- 3 Use the Condition Index to evaluate risks and establish investment priorities.
- Consequences  
(Based on Risk to Revenue or other factors)
- Prepared by HDC  
May 2004  
POC: Lori Rux, HDC-T  
(503) 808-4221